NOAA TECHNICAL MEMORANDUM NWS AR-17

MODIFYING NUMERICAL GUIDANCE IN ALASKA

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ABSTRACT. The primary form of numerical guidance available in Alaska consists of facsimile charts showing numerically analysed and forecast sea level pressure and 500mb maps. While there is considerable emphasis on model output statistics (MOS) in the 48 conterminous states, the emphasis in Alaska is on the facsimile charts. Satellite pictures and locally prepared analyses are the principal tools used to evaluate numerical guidance in Alaska. When it is suspected that numerical guidance will not verify well, the guidance is modified. Generally, modification of guidance involves extrapolating the movement and development of important features on satellite pictures and local analyses.

1. INTRODUCTION

Much has been written about the use and modification of numerical guidance: most literature on the subject pertains to the conterminous United States. Numerical guidance and its interpretation in the 48 States have become quite sophisticated in the past few years. The situation for forecasters in Alaska is different.

Numerical guidance available in Alaska includes the barotropic 500mb prog, the LFM and PE surface and 500mb progs, and the LFM 700mb and QPF progs. These are available as facsimile charts and constitute the backbone of the numerical guidance for Alaska.

A variety of teletype numerical guidance supplements this. This guidance includes the FOUS boundary layer wind forecast (taken from the PE and similar to the PE surface progs), the FOUS QPF, the FD winds and temperatures aloft forecast (also taken from the PE), and the FMAK1 (forecast temperatures, surface winds and probability of precipitation for 14 Alaskan RAOB stations). Thus far, forecasters in Alaska have had only a few weeks experience with the FMAK1 forecast surface winds and probability of precipitation.

In the 48 States, a great deal of additional, detailed numerical guidance is available - including forecasts of temperatures, probability of precipitation, surface wind, ceiling height, visibility, etc. for a large number of RAOB and non-RAOB stations. Such guidance is often called the MOS or model output statistics.

As a result, considerable emphasis is placed on interpreting and modifying the MOS in the 48 States. In Alaska, the emphasis is almost exclusively on the facsimile charts. More Alaskan MOS will be available in the future, but the emphasis on basic facsimile charts will remain for at least several more years.

2. EVALUATION OF NUMERICAL GUIDANCE

Before making any modifications to the numerical guidance, the guidance must be evaluated. There are a number of generalizations that can be made about evaluating the numerical guidance.

1. Numerical guidance can be expected to verify well when:

   a. The initial numerical analysis is accurate.

   b. The previous set of numerical guidance progs was accurate. This is important for two reasons. First, the past 12-hour prog serves as a first-guess for the initial analysis in the new package. This should be considered especially for data-sparse areas like the North Pacific and the Arctic. Second, in the case of the LFM, the conditions around the boundary of the limited forecast area of the LFM are taken from the previous PE prog. So if there is a marked change in the new PE guidance from the previous PE package, it may be assumed that the boundary conditions used in the new LFM initial analysis are probably in serious error. This same conclusion can usually be drawn if there is a large discrepancy between the new 12-hour LFM prog and the old 24-hour PE prog, both verifying at the same time. Since Alaska is very close to the boundary of the LFM forecast area and since Alaska is surrounded by vast data-sparse areas, this is an important consideration.

If it appears the numerical guidance will verify well, all the forecaster has to do is to determine the relationships between important weather areas and features on the facsimile maps, and then forecast the weather accordingly.

2. Numerical guidance will probably not verify well when:

   a. Satellite pictures and local analyses show the short-range numerical guidance is not verifying well. For instance, a 06Z surface analysis might show a fast-moving low well ahead of the position it was forecast to be at on the 12-hour prog verifying at 12Z. A common cause of this failure is the appearance of small-scale, short-lived map features that are important weather producers, e.g., comma clouds in maritime air masses.

b. The numerical guidance forecasts something that is physically unrealistic. Past experience and recall of previous weather situations are a good guide in spotting guidance that falls into this catagory. An example would be a surface prog that forecasts a Pacific low pressure system to move straight north to Fort Yukon during the dead of winter.

c. Satellite pictures and local analyses show that the intitial numerical analysis is in error. Here, one must remember that the barotropic and PE models analyse for grid points set 381 km apart while grid points for the LFM model are only half as far apart. Thus, the LFM can analyse and forecast with greater detail than the PE and barotropic models. One consequence of this is that the LFM is often better in its treatment of small, fast-moving lows that are just developing. Such small systems may be lost between the widely spaced grid points of the PE and barotropic models.

In evaluating numerical guidance, the forecaster is primarily interested in camparing the guidance with the latest analyses and satellite pictures. Comparison of the latest progs with the previous prog packages is useful but secondary in importance. The latest satellite pictures and analyses provide an essential update to the progs.

To the maximum extent possible, analyses prepared in WSFO, Anchorage are drawn to be consistent with the satellite pictures. These analyses include surface maps drawn at synoptic times and 850mb and 500mb maps drawn at 00Z and 12Z. The area covered includes Alaska, west Canada, eastern Siberia, the adjoining areas of the Arctic Ocean, and the North Pacific. Effort is made to analyse map features that can be missed on synoptic maps of the northern hemisphere. Such features include troughs, ridges and lows in data-sparse areas and small lows or short waves that numerical models will not catch. Also included is the 850mb arctic front, which is often an important weather producer in Alaska.

Carefully prepared analyses, incorporating the latest satellite information, are useful in evaluating the numerical guidance and as a diagnostic tool. The forecaster can recognize features on the analyses and satellite pictures that the computer may not see; and the important factor is that the forecaster can exercise judgement in preparing the forecast, while computers and numerical models can not.

3. MODIFICATION OF NUMERICAL GUIDANCE

If evaluation reveals problems with the numerical guidance, the forecaster has the additional job of determining if indeed there is a significant problem with the guidance. If so, he must decide how to modify the guidance. Problems with map features that will not affect the weather forecast do not require modifying the guidance.

Modification of numerical guidance can take a number of general forms:

1. Adjustment of the timing of the movement or development of an important weather system. For instance, satellite pictures and local analyses could show a North Pacific storm about 12 hours ahead of schedule per the LFM surface prog. The solution is to use the 24 hour prog for the 12 hour forecast, the 36 hour prog for the 24 hour forecast, etc.

2. Inclusion of an important system that does not appear on the numerical guidance. An example would be a new frontal wave in the Pacific that shows promise of becoming an important weather producer. The solution here would be to extrapolate the latest movement and development of the system and then to wait and see if it appears on the next set of progs. Some important features, such as the 850mb arctic front, may not be handled explicitly on any progs. The same approach applies: extrapolate present tendencies as revealed by satellite pictures and local analyses.

3. Using a mixed set of progs for the forecast. One of the more challenging forecast situations in Alaska is when all three prog packages -- barotropic, PE and LFM -- are markedly different. In such a case, the forecaster might conclude that the LFM was best in the Gulf of Alaska while the PE was correct over the central Pacific. Another example would be moving a surface low just ahead of a 500mb short wave using the barotropic 500mb prog.

Good results from modifying the numerical guidance often depend heavily on the forecasters past experience and recall of weather situations. This is especially important in handling a system that does not appear at all on any of the progs. Spotting a set of numerical progs that is not likely to verify well is not too difficult. Correctly forecasting a system that is not on the progs at all requires a lot of insight.

Modification, or updating of progs can be done frequently in areas where satellite data is available on a frequent basis. For the North Pacific, SMS satellite pictures are available to forecasters in Alaska every 30 minutes on most days. New developments can be caught early and a complete history of all important weather systems is available. Over the mainland of Alaska, and especially over the Arctic, SMS pictures are of less or no use; satellite coverage is limited to two sets of polar orbit passes per day.

To summarize: modification of numerical guidance in Alaska generally involves extrapolating the movement and development of features revealed by satellite pictures or local analyses. This may result in changing the timing of the movement of a system, inclusion of a system not on the progs, or the decision to use a mixture of the progs for the forecast.

4. CASE STUDY

The following maps and satellite pictures illustrate a case when it was extremely beneficial to modify NMC numerical guidance. The charts also illustrate some problems encountered in Alaska forecasting.

The 12-hour LFM surface prog valid at 12Z March 5, (Fig. 1) had a surface low west of Cold Bay. By the time the surface analysis for 12Z March 5 (Fig. 2) was finished, it was apparent that the LFM 12-hour prog was not moving the low fast enough to the east and did not forecast the low as intense as it actually was.

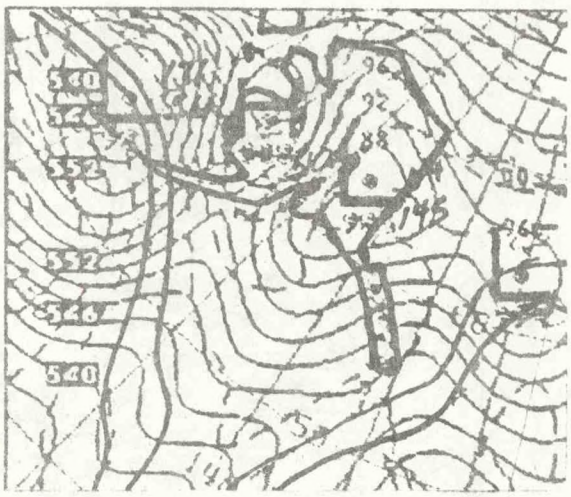

Figure 1. 12-hour LFM surface prog valid 12Z March 5, 1977.

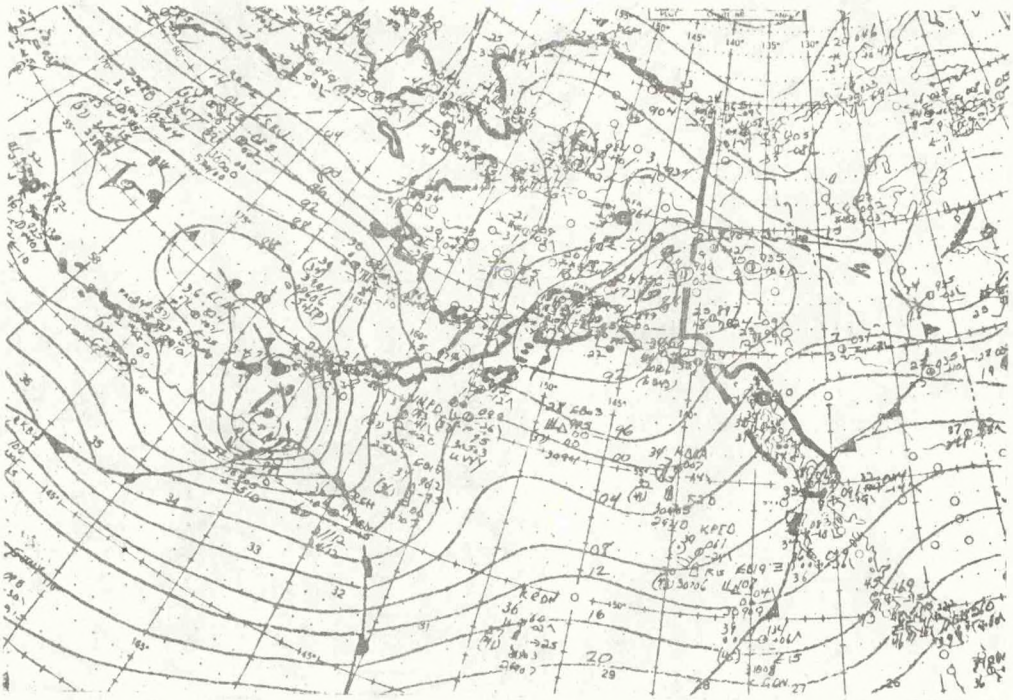

Figure 2. Anchorage surface analysis valid 12Z March 5, 1977.

The 500mb and surface analyses for 12Z March 5 (Figs. 2 and 3) showed the surface low was moving ahead of a fast-travelling 500mb short wave trough in the central Aleutians. Clearly, the numerical guidance was not verifying well on a major system. The modification was to greatly speed up the eastward movement of the low into the Gulf of Alaska, using the past speeds of the surface low and the 500mb short wave behind it as a guide.

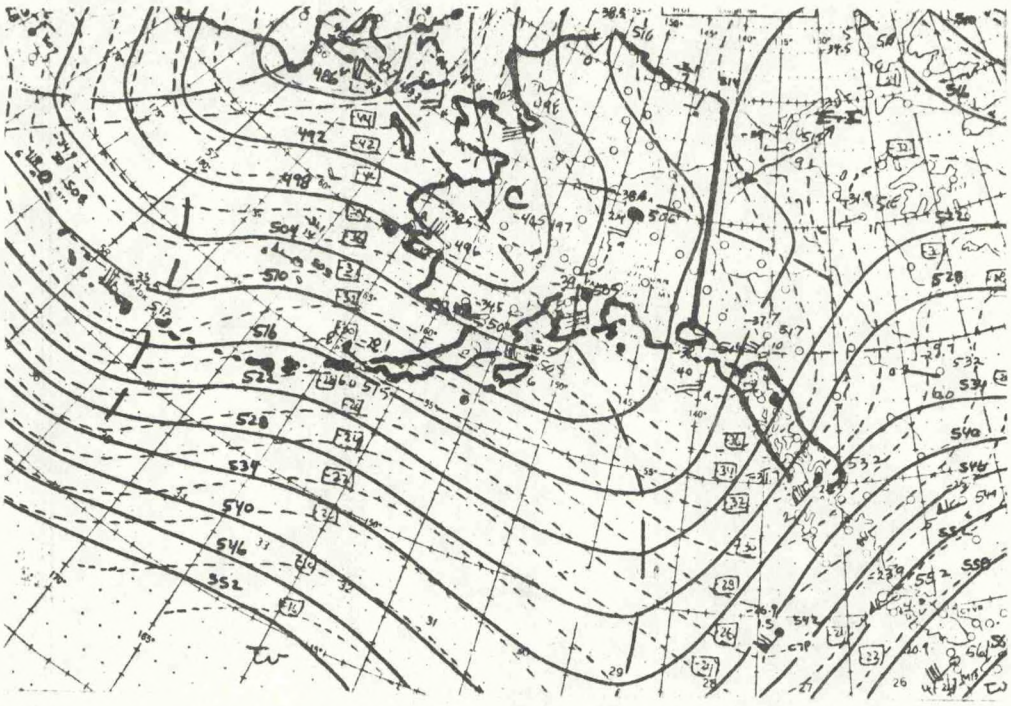

Figure 3. Anchorage 500mb analysis valid 12Z March 5, 1977.

Note that the new LFM 12-hour surface prog valid at 00Z March 6 (Fig. 4) did not differ much from the old LFM 24-hour surface prog (Fig. 5) valid at the same time.

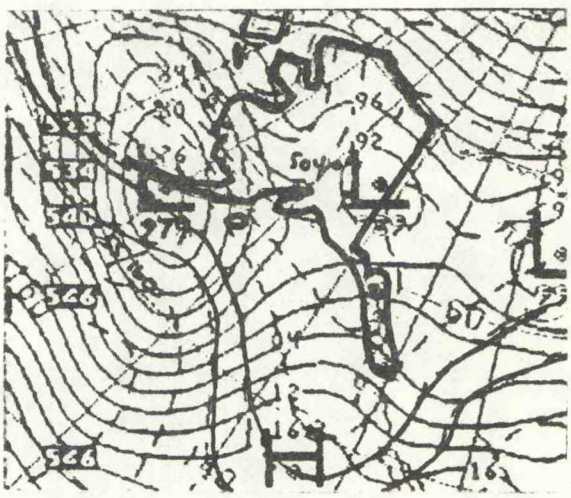

Figure 4. LFM 12-hour surface prog valid 00Z March 6, 1977.

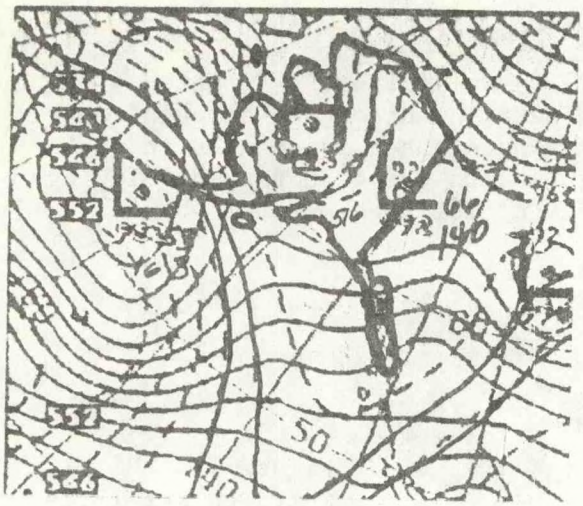

Figure 5. LFM 24-hour surface prog valid 00Z March 6, 1977.

The Anchorage surface analysis valid at 00Z March 6 (Fig. 6) shows the actual track of the low. The recurrence of the forecast error in the new LFM prog series (Fig. 4) has been noted often in past situations.

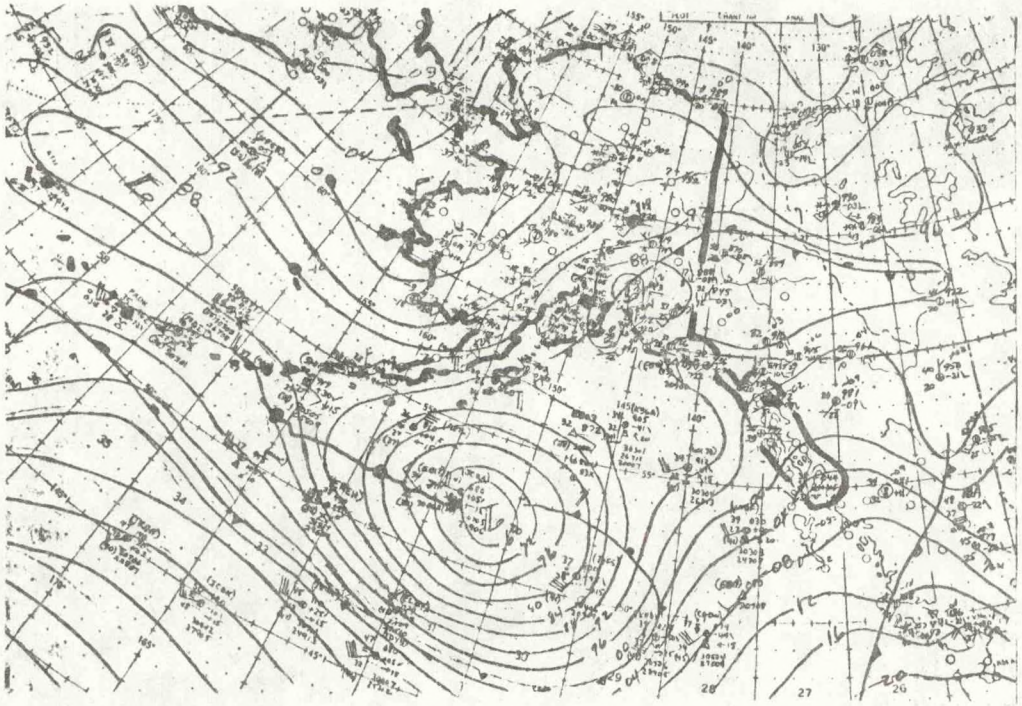

Figure 6. Anchorage surface analysis valid 00Z March 6, 1977.

The SMS satellite pictures (Figs. 7-9) valid from 2345Z March 4 through 2345Z March 5 show the rapid development of the circulation around this strengthening low. As has been noted frequently in the past, the progs are more likely to fall into error in fast-developing situations than during situations with established weather systems.

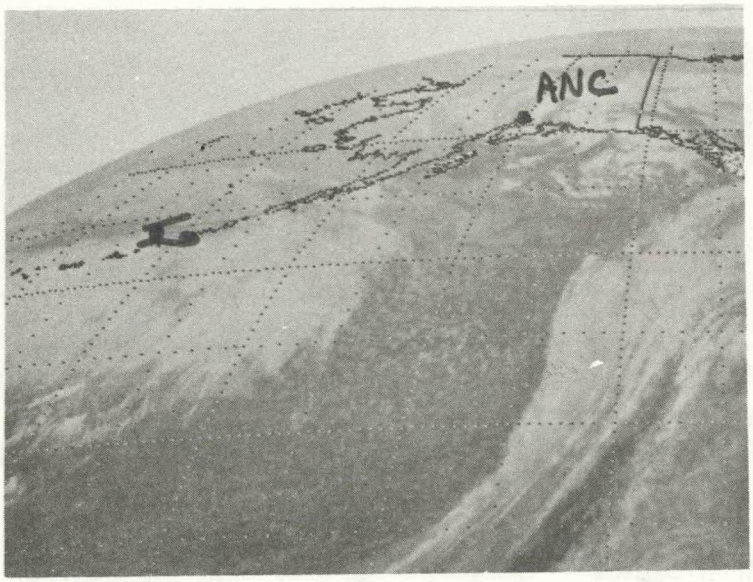

Figure 7. SMS infrared satellite picture 2345Z March 4, 1977.

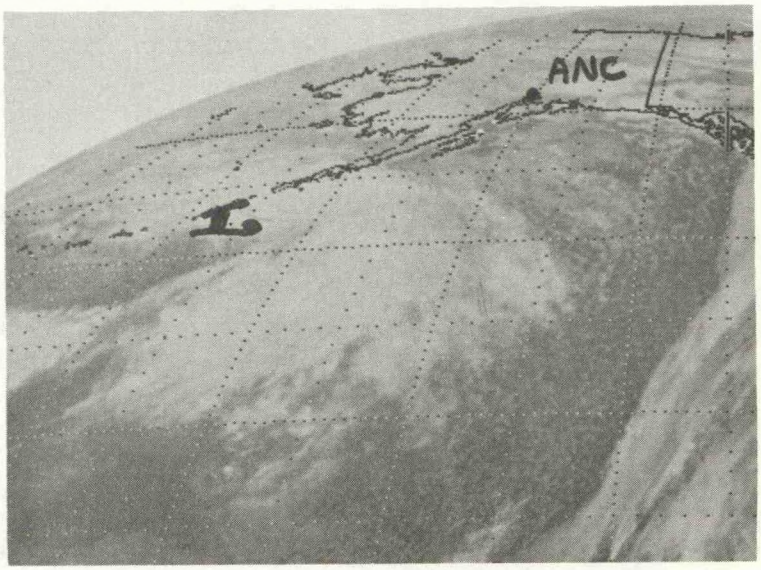

Figure 8. SMS infrared satellite picture 1145Z March 5, 1977.

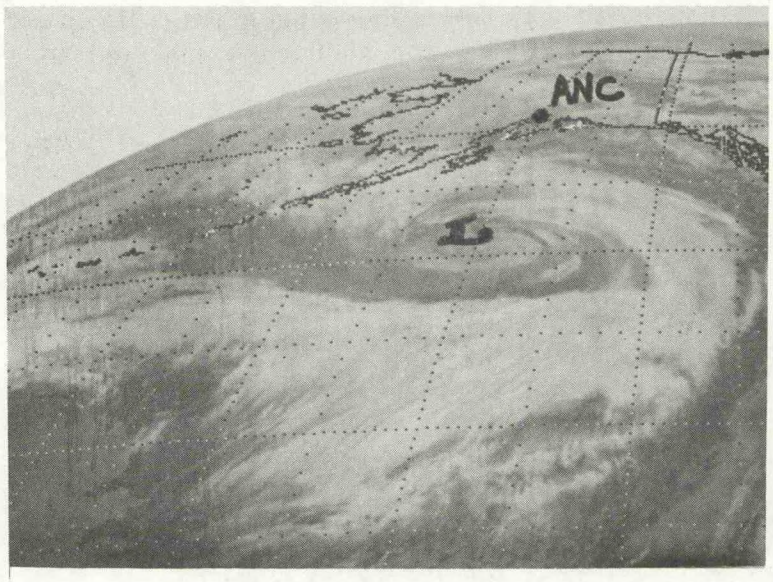

Figure 9. SMS infrared satellite picture 2345Z March 5, 1977.

The interest now turned to the band of clouds approaching Anchorage from the south at 00Z March 6. The 36-hour LFM and PE 500mb progs available at this time (Figs. 10 and 11) were valid at 00Z March 7. The progs both showed a sharp trough moving through Anchorage at that time -- which suggested a very good chance of snow in Anchorage on the afternoon of March 6, Alaska Time.

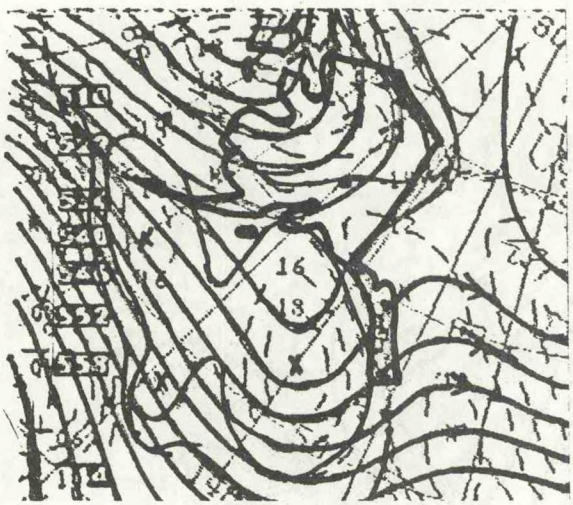

Figure 10. LFM 36-hour 500mb prog valid 00Z March 7, 1977.

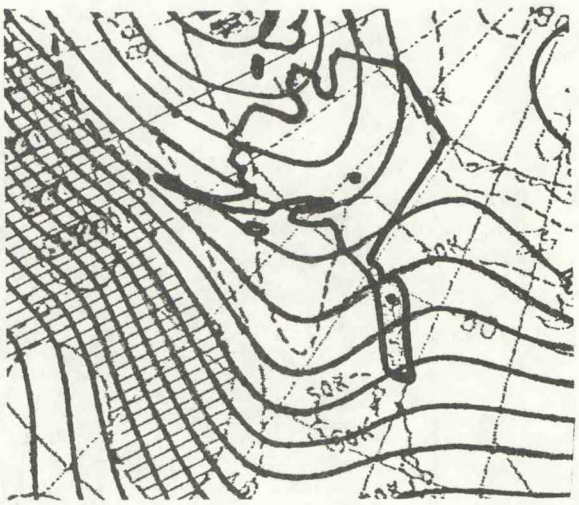

Figure 11. PE 36-hour 500mb prog valid 00Z March 7, 1977.

The LFM 500mb analysis valid at 00Z March 6 (Fig. 12) very nicely verified the LFM 12-hour 500mb prog (Fig. 13), so it looked like snow was in the offing for Anchorage and most of Southcentral Alaska on March 6.

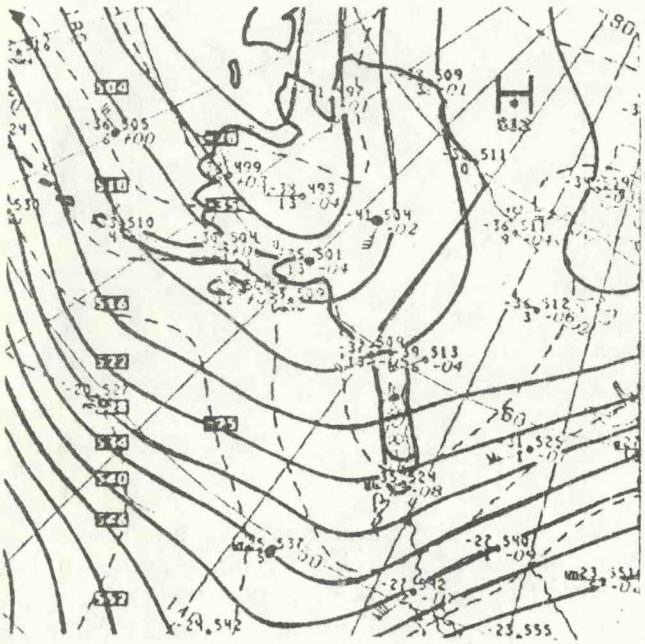

Figure 12. LFM 500mb analysis valid 00Z March 6, 1977.

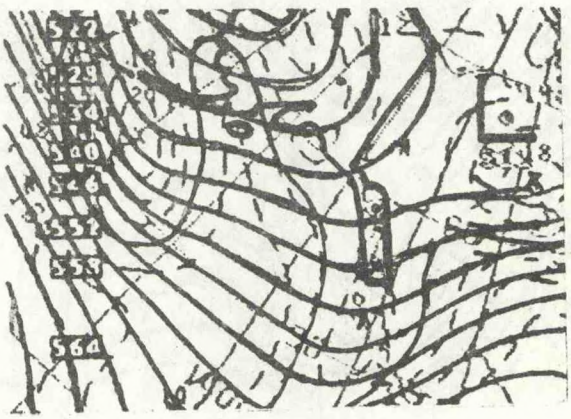

Figure 13. LFM 12-hour 500mb prog valid 00Z March 6, 1977.

However, the analyst in Anchorage noted that the LFM analysis did not properly draw for Ship Papa's wind and did not fit the satellite picture (Fig. 9). The correct analysis (Fig. 14) shows that the fast-moving trough noted earlier had dropped into the Gulf of Alaska and quickly formed a cut-off low.

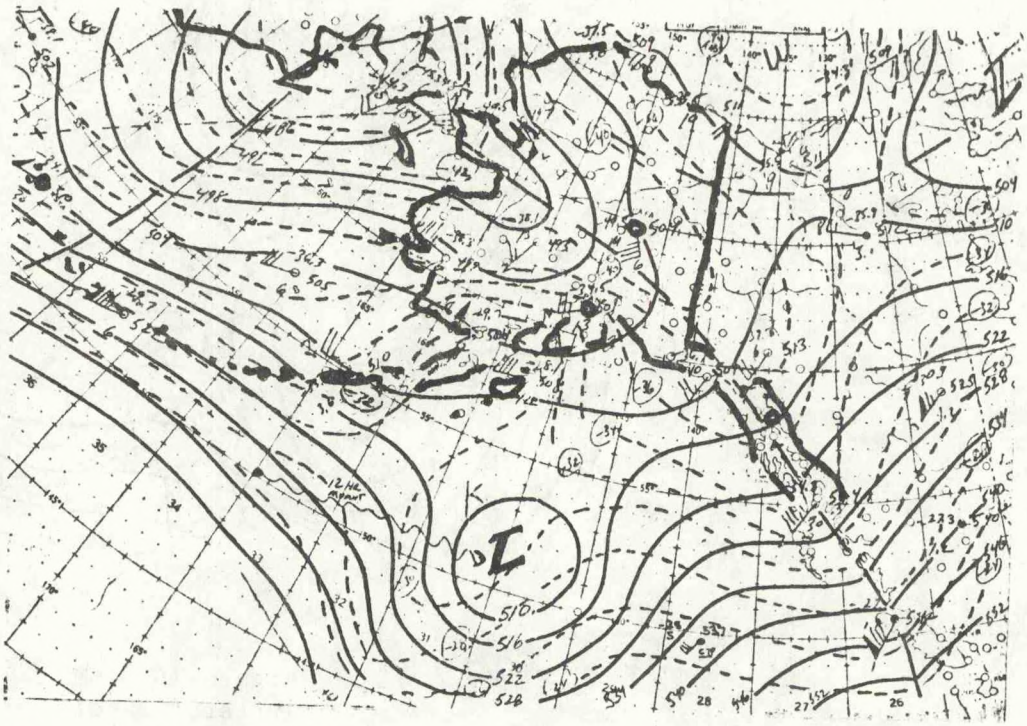

Figure 14. Anchorage 500mb analysis valid 00Z March 6, 1977.

This is a good example of case 2(b) above, in which a poor initial analysis was misleading and would lead to a poor set of progs.

Based on this new evidence, it was determined that the band of clouds south of Anchorage (see Fig. 9) would mainly move to the east as circulation around the cut-off low aloft persisted. The next LFM 500mb analysis (Fig. 15) finally caught this feature, as shown in the satellite picture at 1145Z March 6 (Fig. 16).

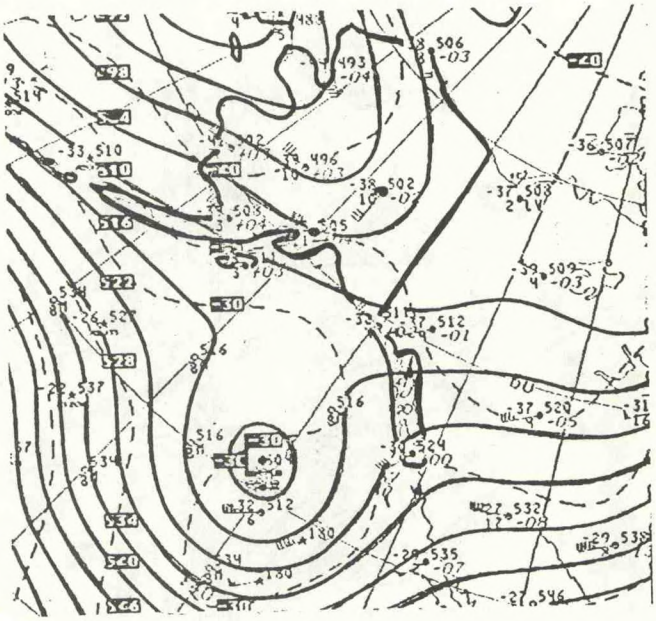

Figure 15. LFM 500mb analysis valid 12Z March 6, 1977.

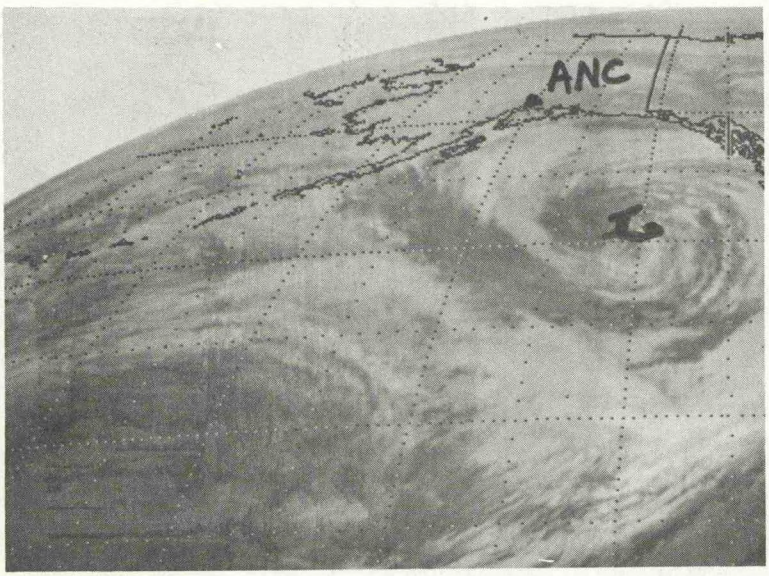

Figure 16. SMS infrared satellite picture 1145Z March 6, 1977.

As it turned out, no precipitation was observed in Anchorage or anywhere in Southcentral Alaska north of Anchorage on March 6 or March 7. Based on the development of the cut-off low at 500mb on the afternoon of March 5, Alaska Time, snow had been omitted from the forecast. The modification of the numerical guidance was correct.

Guidance products issued by WSFO, Anchorage are intended to help the field forecaster identify situations like the example illustrated above. The purpose of the first section of the FPAK1 PANC is to discuss forecast reasoning and to evaluate the numerical guidance. Situations such as the one discussed above are especially suited to this treatment.

Further discussion of the progs can be found in the satellite messages prepared by the Satellite Field Service Stations in Anchorage (TBXX6 PANC -- issued at 0000 GMT and 0900 GMT) and in San Francisco (TBXX6 KSFO -- issued at 0030 GMT, 0630 GMT, 1230 GMT and 1830 GMT).

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